# NATIONAL ENGINEERING COLLEGE

*(An Autonomous Institution Affiliated to Anna University Chennai)*

## K.R.NAGAR, KOVILPATTI

www.nec.edu.in

Estd : 1984

### DEPARTMENT OF

### ELECTRICAL AND ELECTRONICS ENGINEERING

**REGULATIONS – 2023**

**CURRICULUM & SYLLABUS OF**

## M. E. – HIGH VOLTAGE ENGINEERING

## REGULATIONS 2023

## CURRICULUM AND SYLLABUS

### SEMESTER – I

| S. No | Course Code | Course Title | Category | Periods Per Week | | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | | |
| **Theory Courses** | | | | | | | | | |
| 1. | 23HE11C | Mathematical Foundations for High Voltage Engineering | SFC | 3 | 1 | 0 | 0 | 4 | 4 |
| 2. | 23HE12C | Research Methodology and IPR | MC | 2 | 0 | 0 | 0 | 2 | 2 |
| 3. | 23HE13C | Insulation Technology | PCC | 3 | 0 | 0 | 0 | 3 | 3 |
| 4. | 23HE14C | Field Computation and Modeling of Electrical Apparatus | PCC | 3 | 1 | 0 | 0 | 4 | 4 |
| 5. | - | Elective-I | PEC | 3 | 0 | 0 | 0 | 3 | 3 |
| 6. | - | Audit Course-I | AC | 2 | 0 | 0 | 0 | 2 | 2 |
| **Integrated Courses** | | | | | | | | | |
| 7. | 23HE15C | High Voltage Generation and Measurement | PCC | 3 | 0 | 2 | 0 | 5 | 4 |
| **Practical Courses** | | | | | | | | | |
| 8. | 23HE16C | Field Computation Laboratory | PCC | 0 | 0 | 4 | 0 | 4 | 2 |
| | | | | | | | **TOTAL** | **27** | **24** |

### SEMESTER – II

| S. No | Course Code | Course Title | Category | Periods Per Week | | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | | |
| **Theory Courses** | | | | | | | | | |
| 1. | 23HE21C | High Voltage Testing Techniques | PCC | 3 | 0 | 0 | 0 | 3 | 3 |
| 2. | 23HE22C | Electrical Transients in Power System | PCC | 3 | 1 | 0 | 0 | 4 | 4 |
| 3. | - | Elective-II | PEC | 3 | 0 | 0 | 0 | 3 | 3 |
| 4. | - | Elective-III | PEC | 3 | 0 | 0 | 0 | 3 | 3 |
| 5. | - | Audit Course-II | AC | 2 | 0 | 0 | 0 | 2 | 2 |
| **Integrated Courses** | | | | | | | | | |
| 6. | 23HE23C | Insulation design of High Voltage Power Apparatus | PCC | 3 | 0 | 2 | 0 | 5 | 4 |
| **Practical Courses** | | | | | | | | | |
| 7. | 23HE24C | High Voltage Laboratory | PCC | 0 | 0 | 4 | 0 | 4 | 2 |
| 8. | 23HE25C | Mini Project with Seminar | EEC | 0 | 0 | 0 | 4 | 4 | 2 |
| | | | | | | | **TOTAL** | **28** | **23** |

## SEMESTER – III

| S. No | Course Code | Course Title | Category | Periods Per Week | | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | | |
| **Theory Courses** | | | | | | | | | |
| 1. | - | Elective | OEC | 3 | 0 | 0 | 0 | 3 | 3 |
| 2. | - | Elective-IV | PEC | 3 | 0 | 0 | 0 | 3 | 3 |
| **Integrated Courses** | | | | | | | | | |
| 3. | - | Elective-V | PEC | 3 | 0 | 2 | 0 | 5 | 4 |
| **Practical Courses** | | | | | | | | | |
| 4. | 23HE31C | Project Work-I | PCC | 0 | 0 | 12 | 0 | 12 | 6 |
| | | | | | | | **TOTAL** | **23** | **16** |

## SEMESTER – IV

| S. No | Course Code | Course Title | Category | Periods Per Week | | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | | |
| **Practical Courses** | | | | | | | | | |
| 1. | 23HE41C | Project Work-II | PCC | 0 | 0 | 24 | 0 | 24 | 12 |
| | | | | | | | TOTAL | 24 | 12 |

**TOTAL CREDITS: 75**

## PROGRAMME ELECTIVE COURSES (Electives I to IV)

| S. No | Course Code | COURSE TITLE | L | T | P | E | C |
|---|---|---|---|---|---|---|---|
| 1. | 23HE01E | High Voltage Equipments | 3 | 0 | 0 | 0 | 3 |
| 2 | 23HE02E | High Voltage DC Transmission | 3 | 0 | 0 | 0 | 3 |
| 3 | 23HE03E | Condition Monitoring of High Voltage Power Apparatus | 3 | 0 | 0 | 0 | 3 |
| 4 | 23HE04E | EHV AC Power Transmission | 3 | 0 | 0 | 0 | 3 |
| 5 | 23HE05E | Electromagnetic Interference and Electromagnetic Compatibility | 3 | 0 | 0 | 0 | 3 |
| 6 | 23HE06E | Pollution Performance of Power Apparatus and Systems | 3 | 0 | 0 | 0 | 3 |
| 7 | 23HE07E | Advanced Electromagnetic Field | 3 | 0 | 0 | 0 | 3 |
| 8 | 23HE08E | Advanced Topics in High Voltage Engineering | 3 | 0 | 0 | 0 | 3 |
| 9 | 23HE09E | Advances in Electric Power Transmission | 3 | 0 | 0 | 0 | 3 |

| S. No | Course Code | COURSE TITLE | L | T | P | E | C |
|---|---|---|---|---|---|---|---|
| 10 | 23HE10E | Application of AI Techniques to High Voltage Engineering | 3 | 0 | 0 | 0 | 3 |
| 11 | 23HE11E | Machine Learning | 3 | 0 | 0 | 0 | 3 |
| 12 | 23HE12E | Pulse Power Engineering | 3 | 0 | 0 | 0 | 3 |
| 13 | 23HE13E | Design of Substations | 3 | 0 | 0 | 0 | 3 |
| 14 | 23HE14E | Flexible AC Transmission Systems | 3 | 0 | 0 | 0 | 3 |
| 15 | 23HE15E | Power Quality | 3 | 0 | 0 | 0 | 3 |
| 16 | 23HE16E | Restructured Power Systems | 3 | 0 | 0 | 0 | 3 |
| 17 | 23HE17E | Power System Planning and Reliability | 3 | 0 | 0 | 0 | 3 |
| 18 | 23HE18E | Smart Grid | 3 | 0 | 0 | 0 | 3 |
| 19 | 23HE19E | Control of Electric Drives | 3 | 0 | 0 | 0 | 3 |
| 20 | 23HE20E | Advanced Electrical Drives | 3 | 0 | 0 | 0 | 3 |
| 21 | 23HE21E | Evolutionary Computing | 3 | 0 | 0 | 0 | 3 |
| 22 | 23HE22E | Optimization Techniques to High Voltage Engineering | 3 | 0 | 0 | 0 | 3 |
| 23 | 23HE23E | Energy management | 3 | 0 | 0 | 0 | 3 |
| 24 | 23HE24E | Nano Dielectrics | 3 | 0 | 0 | 0 | 3 |
| 25 | 23HE25E | Optimal control and Filtering | 3 | 0 | 0 | 0 | 3 |
| 26 | 23HE26E | Digital Control System | 3 | 0 | 0 | 0 | 3 |
| 27 | 23HE27E | Robotics and Industrial Automation | 3 | 0 | 0 | 0 | 3 |

## PROGRAMME ELECTIVE COURSES (Elective V)

| S. No | Course Code | COURSE TITLE | L | T | P | E | C |
|---|---|---|---|---|---|---|---|
| 1. | 23HE28E | High Voltage Protection and Switchgear | 3 | 0 | 2 | 0 | 4 |
| 2 | 23HE29E | Soft Computing Techniques | 3 | 0 | 2 | 0 | 4 |
| 3 | 23HE30E | Power Electronics in Power Systems | 3 | 0 | 2 | 0 | 4 |
| 4 | 23HE31E | Power System Operation and Control | 3 | 0 | 2 | 0 | 4 |

## OPEN ELECTIVE COURSES

| S. No | Course Code | COURSE TITLE | L | T | P | E | C |
|---|---|---|---|---|---|---|---|
| 1. | 23GD01E | Business Analytics | 3 | 0 | 0 | 0 | 3 |
| 2. | 23GD02E | Industrial Safety | 3 | 0 | 0 | 0 | 3 |
| 3. | 23GD03E | Operations Research | 3 | 0 | 0 | 0 | 3 |
| 4. | 23GD04E | Cost Management of Engineering Projects | 3 | 0 | 0 | 0 | 3 |
| 5. | 23GD05E | Composite Materials | 3 | 0 | 0 | 0 | 3 |
| 6. | 23GD06E | Waste to Energy | 3 | 0 | 0 | 0 | 3 |

## AUDIT COURSES

| S. No | Course Code | COURSE TITLE | L | T | P | E | C |
|---|---|---|---|---|---|---|---|
| 1. | 23AC01E | Technical Report Writing | 2 | 0 | 0 | 0 | 0 |
| 2. | 23AC02E | Disaster Management | 2 | 0 | 0 | 0 | 0 |
| 3. | 23AC03E | Sanskrit for Technical Knowledge | 2 | 0 | 0 | 0 | 0 |
| 4. | 23AC04E | Value Education | 2 | 0 | 0 | 0 | 0 |
| 5. | 23AC05E | Constitution of India | 2 | 0 | 0 | 0 | 0 |
| 6. | 23AC06E | Pedagogy Studies | 2 | 0 | 0 | 0 | 0 |
| 7. | 23AC07E | Stress Management by Yoga | 2 | 0 | 0 | 0 | 0 |
| 8. | 23AC08E | Personality Development through Life Enlightenment Skills | 2 | 0 | 0 | 0 | 0 |

**Distribution of Credit – ME HVE**

| Category | I Sem. | II Sem. | III Sem. | IV Sem. | Credits | Percentage of credits |
|---|---|---|---|---|---|---|
| SFC | 4 | - | - | - | 04 | 05.33 |
| MC | 2 | - | - | - | 02 | 02.67 |
| AC | 2 | 2 | - | - | 04 | 05.33 |
| PCC | 13 | 13 | - | - | 26 | 34.67 |
| PEC | 3 | 6 | 7 | - | 16 | 21.33 |
| OEC | - | - | 3 | - | 03 | 04.00 |
| EEC | - | 2 | 6 | 12 | 20 | 26.67 |
| Total | 24 | 23 | 16 | 12 | 75 | 100.00 |

## 23HE11C MATHEMATICAL FOUNDATIONS FOR HIGH VOLTAGE ENGINEERING

| L | T | P | E | C |
|---|---|---|---|---|
| 3 | 1 | 0 | 0 | 4 |

### COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply the concepts of norm in linear equations.
CO2: learn the concepts of matrix theory.
CO3: apply the concepts of probability in distributions
CO4: interpret the characteristic features of Markovian Queues
CO5: solve Differential Equations using Numerical Methods

### VECTOR AND MATRIX NORM 9+3

Vector Space - Basis – Dimensions – Inner product – Norm - Systems of Linear Equations - Solving Systems of Linear Equations - Linear Independence - Linear Mappings

### ADVANCED MATRIX THEORY 9+3

Eigen values and Eigenvectors - Generalized eigen vectors - Matrix Decompositions – QR decomposition – Singular value decomposition – Pseudo inverse – Least square approximations.

### RANDOM VARIABLES 9+3

Random variables – Discrete and continuous – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal Distributions.

### QUEUEING MODELS 9+3

Poisson Process – Markovian queues – Single and Multi Server Models – Little formulae – Machine Interference Model – Steady State analysis – Self Service queue.

### NUMERICAL METHODS 9+3

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace and Poisson equations – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank - Nicolson implicit scheme – Solution of wave equation.

**L: 45; T: 15; TOTAL: 60 PERIODS**

### REFERENCES

1. Seymour Lipschutz, Marc Lipson, “Schaum's Outline of Linear Algebra”, 6th Edition, McGraw-Hill Education, 2017
2. Richard Bronson “Schaum's Outline Theory And Problem of Matrix Operations”, 2nd Edition, Tata McGraw Hill, 2018
3. Taha, H. A., “Operations Research: An Introduction”, 10th Edition, Pearson Education Edition, Asia, New Delhi, 2019.
4. Miller and Freund, “Probability and Statistics for Engineers”, 9th Edition, Pearson Education Edition, 2018.
5. John.F.Shortle, James.M.Thompson, Donald Gross and Carl M. Harris, “Fundamentals of Queueing theory”, 5th Edition, John Wiley and Sons, 2018.
6. Numerical Linear Algebra – Sundara Pandian, Prentice Hall India Learning Private Limited, Delhi, 2014

**23HE12C RESEARCH METHODOLOGY AND IPR** **L T P E C**
**2 0 0 0 2**

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: Understand research problem formulation.
CO2: Analyze research related information.
CO3: Understand the research ethics.
CO4: Understand when IPR would take such important place in growth of individuals & Nation.
CO5: Recognize the importance of Report writing.

**RESEARCH FORMULATION AND DESIGN** **6**

Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review - primary and secondary sources, reviews, monographs, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research databases, development of working hypothesis – Case study

**DATA COLLECTION AND ANALYSIS** **6**

Method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statistical packages (SigmaSTAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing – Data Mining (case studies)

**RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING** **6**

Ethics - ethical issues, ethical committees (human and animal); IPR- intellectual property rights and patent law, commercialization, copyright, royalty, trade related aspects of intellectual Property rights (TRIPS); scholarly publishing - IMRAD concept and design of research papers; citation and acknowledgement, plagiarism, reproducibility; and accountability

**CONTEMPORARY ISSUES IN IPR** **6**

Interface between IPR and Human Rights -Interface between IPR and Competition Law -IPR and sustainable development – Impact of Internet on IPR - IPR of Biological systems & E-Commerce.

**INTERPRETATION AND REPORT WRITING** **6**

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., An introduction to Research Methodology-‖, RBSA Publishers, 2015
2. Kothari, C.R., Research Methodology: Methods and Techniques‖, New Age International, 2018 (Unit 1, Unit 2, Unit 5).
3. Wadehra, B.L. Law relating to patents, trademarks, copyright designs and geographical indications‖. Universal Law Publishing, Reprint, 2011. (Unit 3, Unit 4)
4. Anthony, M., Graziano, A.M. and Raulin, M.L. Research Methods: A Process of Inquiry, Allyn and Bacon 2012.
5. Carlos, C.M., Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York, 2000.

**23HE13C** **INSULATION TECHNOLOGY** **L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: summarize the different types of insulation materials and its properties.
CO 2: analyze the fundamental behavior of dielectrics in static and alternating field.
CO 3: dissect the different breakdown mechanism in gaseous dielectrics
CO 4: perceive the various breakdown mechanisms in solid and liquid dielectrics
CO 5: select the suitable insulation for HV power equipment and estimate its lifetime

**INTRODUCTION** **9**

Types of dielectrics and electrical insulation systems – properties of dielectric materials - gaseous, vacuum, liquid, solid and composite insulation – polymers as dielectrics - polymer structure and morphology - classification of polymers -Introduction to nano dielectrics – electrical degradation.

**BEHAVIOUR OF DIELECTRICS IN STATIC AND ALTERNATING FIELD** **9**

Static dielectric constant – atomic interpretation of the dielectric constant of mono-atomic gases – dependence of permittivity on various factors - polarization – types -– internal field in solids and liquids – Frequency dependence of the polarization – complex dielectric constant of non-dipolar solids – dipolar relaxation – dielectric losses.

**BREAKDOWN MECHANISMS IN GASEOUS DIELECTRICS** **9**

Behaviour of gaseous dielectrics in electric fields – different ionization processes - gaseous discharges –– effect of electrodes on gaseous discharge – Townsend's theory, Streamer theory – electronegative gases, gaseous discharges in non-uniform fields – alternate Green gases and mixture of gases- breakdown in vacuum insulation .

**BREAKDOWN MECHANISMS IN SOLID AND LIQUID DIELECTRICS** **9**

Solid Dielectrics - Intrinsic breakdown of solid dielectrics – electromechanical breakdown-Streamer breakdown, thermal breakdown - electrochemical breakdown – tracking and treeing – thermal and electrical ageing and partial discharges – breakdown in composite insulation.

Liquids dielectrics- conduction and breakdown in pure and commercial liquids - Dissolved gas analysis -Cryogenic insulation-Biodegradable oils

**LIFE ESTIMATION AND APPLICATION OF INSULATING MATERIALS** **9**

Life estimation- thermal modelling- DP/Furan/DGA Results and Application of insulating materials in power equipment and recent advancements-environment friendly and recyclable insulation.

L: 45; TOTAL: 45 PERIODS

**REFERENCES**

1. Adrinaus, Dekker J., "Electrical Engineering Materials", Prentice Hall of India Pvt. Ltd., New Delhi, 1979.
2. Alston L.L, "High Voltage Technology", Oxford University Press, London, 1968 (B.S. Publications, 1st Indian Edition, 2006).
3. Kuffel E., Zaengl W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India Pvt. Ltd, 2008.
4. Dieter Kind and Hermann Karner, "High Voltage Insulation Technology", (Translated from German by Narayana Rao Y., Friedr. Vieweg & Sohn, Braunschweig), 1985.
5. Naidu M.S. and Kamaraju V., "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2013.

6. Ushakov V.Y., "Insulation of High Voltage Equipment", Springer, ISBN.3-540- 20729- 5, 2004.
7. R.E.james and Q.Su, "Condition Assessment of High Voltage Insulation in Power System Equipment", IET publications,London,U.K,2008
8. T. S.Ramu and Chakradhar Reddy, 'Reliability and Life estimation of Power Equipment", New Age International 2009.
9. Bottcher C.J.F., Theory of Electric Polarisation, Elsevier Publication, 1962.
10. Wadhwa C. L., High Voltage Engineering, Wiley Eastern Limited, NewDelhi,1994
11. Mann N.R. Schafer R.E. and Singpurwalla N.D., Methods of Statistical Analysis and Life Data, John Wiley and Sons, New York, 1974.
12. B. Tareev, "Physics of Dielectric Materials", Mir Publishers Moscow, 1979

## 23HE14C FIELD COMPUTATION AND MODELING OF ELECTRICAL APPARATUS

**L T P E C**
**3 0 0 0 3**

### COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: recall the basic concepts in electric and magnetic fields. (K2)
CO2: choose the new techniques to find the solutions of electrostatic boundary value problems.(K2)
CO3: improve the new techniques to achieve the accurate results.(K2)
CO 4: determine and find the various parameters of field configurations. (K2)
CO5: model the various electrical apparatus.(K2)

### ELECTRIC & MAGNETIC FIELD – INTRODUCTION 9

Electric field–Coulombs law–Gauss Law–Electric Dipole-Electric fields in material space Polarization–Magnetic field–Amperes Law–Faradays Law–Maxwell's equation- principle of energy conversion.

### SOLUTIONS OF FIELD EQUATIONS– ANALYTICAL METHODS 9

Limitations of the conventional design procedure need for the field analysis based design - Problem definition and solution by analytical methods - Direct integration method - Method of images

### SOLUTIONS OF FIELD EQUATIONS–NUMERICAL METHODS 9

Field Plotting –Finite element method (FEM)–Stiffness matrix- shape functions- Finite Difference Method (FDM)–Moment method

### FIELD COMPUTATION FOR BASIC CONFIGURATION 9

Computation of electric and magnetic field intensities – Capacitance and Inductance – Force, Torque, and Energy for basic configurations – skin effect.

### DESIGN APPLICATIONS 9

Resistive and capacitive field computation-Electromagnetic modelling of Insulators Bushings, Transformers –Rotating machines for power frequency and impulse voltages.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Mathew Sadiku,"Elements of Electromagnetics", Oxford University Press,6th Edition,2015.
2. Sivaji Chakravorti, "Electric Field Analysis", CRC Press (Taylor & Francis), USA, 2015.
3. NathanIda, JoaoP .A .Bastos, "Electromagnetics and calculation of fields", Springer Verlage, 2nd Edition, 2002.
4. Nicola Biyanchi, "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
5. S.J Salon, "Finite Element Analysis of Electrical Machines."Kluwer Academic Publishers, London, 1995 (distributed by TBH Publishers & Distributors, Chennai, India).
6. User manuals of MAGNET, MAXWELL& ANSYS software.
7. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, 3rd Edition, 1996.
8. William Hayt, "Engineering Electromagnetics" Tata Mc Graw-Hill Edition, 2012.

**23HE15C HIGH VOLTAGE GENERATION AND MEASUREMENT L T P E C**
**3 0 2 0 4**

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: explain the need for the generation of high AC, DC Voltage. (K2)
CO2: describe the principles behind generation of impulse voltages and current. (K2)
CO3: understand the principle of high AC voltage and current measurement systems (K2)
CO4: explain the measurement techniques of high DC voltage and current.(K2)
CO5: outline the application areas of high voltage engineering. (K2)
CO6: Demonstrate the generation methods of high DC (K2)
CO7: Demonstrate the generation methods of high AC (K2)
CO8: Demonstrate the generation methods of high Impulse voltages. (K2)
CO9: Measurement methods of high AC, DC and impulse voltages. (K2)
CO10: Describe the simulation of lightning and switching impulse currents (K2)

**GENERATION OF HIGH DC VOLTAGES 9 + 6**

**Theory:**

Need for generating high voltages – Requirements of HV generation in laboratory-Role of the insulation in power apparatus and systems- Generation of DC Voltages- Rectifier circuits- cascade circuits- Voltage Multiplier Circuits- Cockcroft Walton circuit- voltage regulation- electrostatic generators.

**Practice:**

Generation of HVDC with different sphere gap spacing

**GENERATION OF HIGH AC VOLTAGES 9 + 6**

**Theory:**

Testing transformer- Single unit testing transformer- cascaded transformer- equivalent circuit of cascaded transformer- resonant circuits- resonant transformer- voltage regulation.

**Practice:**

Generation of HVAC with different sphere gap spacings

**GENERATION OF IMPULSE VOLTAGES 9 + 6**

**Theory:**

Impulse voltage: lightning impulses, switching Impulses- generator circuit – Marx generator – analysis of single stage and multistage circuits-wave shaping- modeling of impulse generator circuit-triggering and control of impulse generators - generation of switching surge voltage and currents- generation of non- standard impulse voltages and very fast transient voltage (VFTO)- generation of impulse current.

**Practice:**

Generation of Impulse Voltage with various gap spacing and Positive and Negative Polarity

**MEASUREMENTS OF HIGH VOLTAGES** **9 + 6**

**Theory:**

Measurement of high DC voltages: Sphere gaps, factors affecting sphere gap measurements, correction factors- Measurement of high AC voltage: Capacitance voltage dividers, Chubb-Fortescue method, CVT, electrostatic voltmeters- Measurement of Impulse voltages – fast digital transient recorders for impulse measurement - high AC current: resistive shunts- electromagnetic current transformer-Relevant IS and IEC Standards.

**Practice:**

Measurement of breakdown strength of air medium with high AC voltage under uniform and non uniform field Measurement of switching impulse voltage

**GENERATION AND MEASUREMENTS OF IMPULSE CURRENTS** **9 + 6**

**Theory:**

Generation of impulse currents, conversion of impulse voltage generator to impulse current generator- Measurement of high AC,DC and Impulse currents- Resistive shunts- Resistive shunts- Magnetic links -Hall effect generators-magneto-optical method and current transformers.

**Practice:**

Simulation of Lightning and Switching Impulse

**L: 45; P: 30; TOTAL: 75 PERIODS**

**REFERENCES**

1. Kuffel, E., Zaengl, W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsvier India Pvt. Ltd, 2nd Edition, 2008
2. Dieter Kind, Kurt Feser, “High Voltage Test Techniques”, Newnes, 2nd Edition, 2001.
3. Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-hill Publishing Company Ltd., 5th Edition, New Delhi, 2020.
4. Gallagher, T.J., and Permain, A., “High Voltage Measurement, Testing and Design”, John Wiley Sons, New York, 1984.
5. R.Mazen Abdel-Salam, Hussein Anis, Ahdab El-Morshedy, RoshdyRadwan, “High Voltage Engineering Theory and Practice” 2nd Edition, Revised and Expanded, Marcel Dekker, Inc., New York, 2000.
6. N.H.Malik, A.A.Al_Arainy, M.I.Qureshi, “Electrical Insulation in Power Systems”, Marcel Dekker, Inc., New York 1988.
7. Adolf J. Schwab, “High Voltage Measurement Techniques”, M.I.T Press, 1972.

**23HE16C** **FIELD COMPUTATION LABORATORY** **L T P E C**
**0 0 4 0 2**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: interpret the field distribution model of insulating/dielectric medium.(K2)

CO2: analyze the generation of transient and over voltages using simulation tool.(K2)

**LIST OF EXPERIMENTS**

1. Electrostatic Analysis of Single and multiple dielectric capacitance model using FEM
2. Modelling of high voltage porcelain insulator with and without contamination layer using FEM
3. Modelling of high Voltage Transformer using FEM
4. Modelling of high voltage glass insulator with and without contamination layer using FEM
5. Modelling of solid dielectric material with different size of void and position using FEM
6. Simulation of Lightning and Switching Impulse voltage generator
7. Simulation of RL,RC and RLC-DC transient circuit
8. FEM Simulation of different electrode configurations

**P: 60; TOTAL: 60 PERIODS**

**23HE21C HIGH VOLTAGE TESTING TECHNIQUES L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO 1: explain different types of testing and measurement techniques.
CO 2: Interpret the life time analysis data and statistical evaluation of measured results
CO 3: Experiment with different test procedures for HV power apparatus as per standards.
CO 4: explain non-destructive insulation test for assessing insulation characteristics
CO 5: Execution of artificial pollution test and design different types of HV laboratory

**INTRODUCTION 9**

Objectives of high voltage testing - classification of testing methods- indoor and outdoor insulations - self restoration and non-self restoration systems-standards and specifications, measurement techniques, Diagnostic testing, online measurement – influence and correction of ambient condition.

**STATISTICAL EVALUTION OF MEASURED RESULTS 9**

Determination of probability values, Distribution function of a measured quantity, confidence limits of the mean values of disruptive discharges – 'Up and Down' method for determining the 50% disruptive discharge voltage - multi stress ageing - life data analysis

**TESTING TECHNIQUES FOR ELECTRICAL EQUIPMENT 9**

Testing of insulators, bushings, surge arresters, power transformer, cables - testing methodology: various type tests, sample tests, routine tests - recording of oscillograms - interpretation of test results.

**NON-DESTRUCTIVE INSULATION TEST TECHNIQUES 9**

Dynamic properties of dielectrics-dielectric loss and capacitance measurement-partial discharge measurements-basic partial discharge (PD) circuit – PD currents- PD quantities -Digital PD instruments and measurements, acoustic emission technique and UHF Techniques for PD identification, Corona and RIV measurements on line hardware.

**POLLUTION TESTS AND DESIGN OF HIGH VOLTAGE LAB 9**

Artificial Pollution tests- salt-fog method, solid layer method, Dimensions of High voltage

laboratory, equipment- fencing, earthing and shielding.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Dieter Kind, Kurt Feser, “High voltage test techniques”, SBA Electrical Engineering Series, New Delhi,1999.
2. Naidu M.S. and Kamaraju V., “High Voltage Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
3. Kuffel, E., Zaengl, W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsvier India P Ltd, 2005
4. Gallagher, T.J., and Pearmain A., “High Voltage Measurements, Testing and Design”, John Willey & Sons, New York, 1983.
5. IS, IEC and IEEE standards for “Dielectric Testing of High Voltage Apparatus”, W.Kennedy, “Recommended Dielectric Tests and Test Procedures for Converter Transformer and Smoothing Reactors”, IEEE Transactions on Power Delivery, Vol.1, No.3, pp 161-166, 1986.
6. Nelson W., “Applied Life Data Analysis”, John Wiley and Sons, New York, 1982.
7. IEC – 60270, “HV Test technique – Partial Discharge Mechanism”, 3rd Edition, December 2000.

**23HE22C ELECTRICAL TRANSIENTS IN POWER SYSTEM**

| L | T | P | E | C |
|---|---|---|---|---|
| 3 | 0 | 0 | 0 | 3 |

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: understand travelling wave propagation on transmission lines. (K2)
CO 2: describe the transient effects in power networks and components (K2)
CO 3: explain the source and characteristics of lightning, switching, and temporary over voltages. (K2)
CO 4: describe the EMI issues related to high voltage engineering (K2)
CO 5: select various protective devices and insulation level. (K2)

**TRAVELLING WAVES ON TRANSMISSION LINE** **9**

Circuits with Lumped and Distributed Parameters– Wave Equation – Reflection, Refraction, Behavior of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion – Multi-conductor system and Velocity wave.

**COMPUTATION OF POWER SYSTEM TRANSIENTS** **9**

Principle of digital computation – Matrix method of solution- Modal analysis- Z transform, Modelling for computation of electromagnetic transients-MNA Program -wavelet technique for determining fault in transformer.

**LIGHTNING, SWITCHING AND TEMPORARY OVERVOLTAGES** **9**

Lightning: Physical phenomena of lightning – Interaction between lightning and power system – Influence of tower footing and earth Resistance- Protection by ground wires- Switching over voltages: Energizing transients - closing and re-closing of lines –Switching of cables and capacitor banks, Short line or kilometric fault, - Very Fast Transient Overvoltage (VFTO) -Temporary overvoltages: line dropping, load rejection, over voltages induced by fault, Ferranti effect, Ferromagnetic resonance.

**BEHAVIOUR OF EQUIPMENTS UNDER TRANSIENT CONDITION** **9**

Initial and Final voltage distribution – Winding oscillation – Traveling wave solution – Behavior of the transformer core under surge condition – Rotating machine – Surge in generator and motor – Surge Arrestors.

**INSULATION CO-ORDINATION** **9**

Definitions, Principle of insulation coordination, Volt-time curves-Rated withstand voltage levels and clearances, relevant standard-Air Insulated Substation (AIS) and Gas Insulated Substation (GIS) – Insulation level – Statistical approach – Coordination between insulation and protection level –Overvoltage protective device.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991.
2. Juan A. Matinez-velasco, “Power system Transients- Parameter determination”, CRC press, 2010
3. Philip C. Magnusson, Gerald C. Alexander, Vijai K Tripathi, Andreas Weisshaar, “Transmission lines and wave propagation”, CRC press, 2001.
4. Arieh L. Shenkman, “Transient analysis of Electric power circuits Handbook”, Springer, 2005.
5. Pritindra Chowdhari, “Electromagnetic transients in Power System”, John Wiley and Sons Inc., 1996.
6. Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2009.
7. Working Group 33/13-09, “Very fast transient phenomena associated with Gas Insulated System”, CIGRE, 33-13, pp. 1-20, 1988.

**23HE23C INSULATION DESIGN OF HIGH VOLTAGE POWER APPARATUS** **L T P E C**
**3 0 2 0 4**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: summarize the different types of insulation materials and its properties.
CO 2: analyze the fundamental behavior of dielectrics in static and alternating field.
CO 3: dissect the different breakdown mechanism in gaseous dielectrics
CO 4: perceive the various breakdown mechanisms in solid and liquid dielectrics
CO 5: select the suitable insulation for HV power equipment and estimate its lifetime
CO 6: understand the conditions of different dielectrics using non-destructive test techniques.
CO 7: infer the quality of high voltage insulators and cables
CO 8: estimate the performance of liquid dielectric medium

**INTRODUCTION** **9 + 6**

**Theory:** Electric field distribution and breakdown strength of insulating materials, factors affecting breakdown strength- uniform and non uniform fields- symmetrical and asymmetrical electrode configurations-fields in single and multi dielectric materials- dielectric refraction: transverse, longitudinal and inclined boundary conditions- electric stress control methods.

**Practice:** 1. Breakdown strength of solid, liquid and Gas insulating medium.

2. Electric field distribution in single and multi dielectric materials using simulation tool.

**HV INSULATORS AND BUSHING** **9 + 6**

**Theory:** Types of insulators- properties- materials- applications- limitations- pollution flashover mechanism- levels of pollution- mitigation techniques- profile selection with respect to environmental conditions- Relevant standards for design- Bushing types- field control methods- design methodology- applications.

**Practice:** 1.Determination of 50% critical impulse flash over voltages on 11 kV insulator and Bushing with Positiveand Negative Polarity.

**POWER TRANSFORMER** **9 + 6**

**Theory:** Insulation schemes- types of windings-calculation of winding capacitance and inductance- surge phenomenon- voltage distribution- stress control methods- insulating materials-transformer insulation- Effects of Environmental Factors in Transformer's Insulation Life.

**Practice:** stress control methods for different types of windings in transformer

**CABLES** **9 + 6**

**Theory:** Types of cables- materials used- cable constants- stress-losses- DC and sub sea cables- partial discharge in cable- treeing- ageing- life estimation- grading - Criteria influencing the selection and design of HV

**Practice:** 1. Measurement of Partial Discharge in cable
2. Power frequency test in cable
3. Design of cable joints (capacitive grading)

**SURGE ARRESTER** **9 + 6**

**Theory:** Types of arresters- V-I characteristics of SiC and ZnO- design of lightning arrester based on housing materials- supporting structure – modelling of arrester- voltage distribution along the arrester-insulation coordination.

**Practice:** 1. Study of insulation coordination in surge arresters with grading ring.

**L: 45; P: 30; TOTAL: 75 PERIODS**

**REFERENCES**

1. Dieter Kind and Hermann Karner, “High Voltage Insulation Technology”, (Translated from German by Narayana Rao Y., Friedr. Vieweg & Sohn, Braun schweig), 1985.
2. Alston. L.L “High Voltage Technology”, Oxford university Press, London 1968.
3. Kuffel E., Zaengl W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsvier India Pvt. Ltd, second edition,2008.
4. Alston, L.L, “High Voltage Technology”, Oxford University Press, London 1968.
5. Karsai, K.Kerenyi, D. and Kiss. L., “Large Power Transformers”, Elsevier, Armsterdam, 1987.
6. Feinberg, R., “Modern Power Transformer Practice”, the Macmillan Press Ltd., New York, 1979.
7. Looms, J.S.T, “Insulators for High Voltages”, IET, London, U.K, 1988.
8. IEC 60815 Part 1,2,and 3 (2014), “Selection and Dimensioning of Polluted Insulators”

**23HE24C** **HIGH VOLTAGE LABORATORY** **L T P E C**

**0 0 4 0 2**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: infer the conditions of different insulating material using various non-destructive test techniques. (K2)

CO2: interpret the quality of high voltage insulators and cables. (K2)

CO 3: evaluate the performance of liquid dielectric medium. (K2)

**LIST OF EXPERIMENTS**

1. Study of AC, DC and LI breakdown voltage of air under uniform and Non- Uniform electrode configurations
2. Measurement of Viscosity of liquid dielectrics
3. Measurement of pH
4. Measurement of Conductivity of samples
5. Study of impulse voltage breakdown characteristics of air under different pressures.
6. Measurement of Partial Discharge in dielectric using Partial Discharge Meter
7. Dielectric withstand tests on Various types of Insulator (dry and wet condition)
8. Dielectric withstand tests on Bushing (dry and wet condition)
9. Design of insulator with grading and corona rings
10. Design of condenser and non-condenser bushing
11. Electric field in homogeneous and non-homogeneous materials i. Symmetrical and asymmetrical electrode configurations ii. Parallel plate, coaxial cable and concentric spheres
12. Critical Flashover of a Sphere Gap using IVG (Virtual Lab)

**P: 60; TOTAL: 60 PERIODS**

**23HE01E HIGH VOLTAGE EQUIPMENTS L T P E C**
**3 0 0 0 3**

**COURSEOUTCOMES**

Upon completion of this course, the students will be able to

CO1: outline the basic concepts of circuit breakers (K2)

CO2: inspect the behavior of HV Power Transformer (K2)

CO3: identify the appropriate bushing techniques for high voltage applications (K2)

CO4: illustrate the basic concepts of different types of cables and protection devices (K2)

CO5: appraise the theory of Gas Insulated Substation(K2)

**HIGH VOLTAGECIRCUITBREAKERS 9**

Arc interruption concept – Circuit making and breaking – Types – Air break, SF6 and vacuum circuit breakers.

**HIGH VOLTAGE POWER TRANSFORMER 9**

Transformer insulation requirements – Dielectric strength and voltage conditions – Winding arrangements – Surge behavior – Behavior of liquid dielectric – Electrode surface phenomena –Gas evolution–Processing techniques–Construction of EHV transformer–Short circuit behavior.

**HIGH VOLTAGE BUSHINGS 9**

Types – Non-condenser bushing – Condenser bushing – Bushing application for different equipments like Alternator, transformer, switchgear, wall bushing – Design of bushing and testing procedures.

**HIGHVOLTAGE CABLESANDHIGH PROTECTIONDEVICES** **9**

Different types of cables – Paper insulated cables – XLPE cables – Gas-filled cables – Types, Working and applications of Insulators, Surge Diverter, Lighting Arrester, Disconnect switches.

**GAS INSULATED SUBSTATION (GIS)** **9**

Comparison of GIS and air insulated substations — Design and layout of GIS — Description of various components of GIS-Advantages of GIS.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Anthony J. Pansini, “Electrical Transformers and Power Equipment”, 3rd Edition, Prentice Hall Publications, 1999.
2. Ruben D.Garzon, “High Voltage Circuit Breakers: Design and Applications”, 2nd Edition, Taylor and Francis Publications, 2005.
3. Nakanishi, “Switching Phenomena in High-Voltage Circuit Breakers”, Marcel Dekker Inc, 1991.
4. M.S.Naidu, “Gas Insulated Substations”, L.K. International Publishing House Pvt. Ltd, 2008.
5. Colin Bayliss, Colin R. Bayliss, Brian J. Hardy, “Transmission and Distribution Electrical Engineering”, Elsevier Ltd., 2012

**23HE02E HIGH VOLTAGE DC TRANSMISSION** **L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: Demonstrate the knowledge of different types of HVDC transmission system (K2)
CO 2: Discuss the operation of HVDC converters (K2)
CO 3: Describe about HVDC control and its operation (K2)
CO 4: Knowledge about filters and protection strategies in HVDC (K2)
CO 5: Explain Recent trends in HVDC transmission and its application (K2)

**INTRODUCTION** **9**

Introduction to HVDC transmission, Comparison between HVAC and HVDC systems - Economic, technical and reliability, limitations, Types of HVDC links - monopolar, bipolar and homopolar links, Components of HVDC transmission system.

**ANALYSIS OF HVDC CONVERTERS** **9**

Rectifier and Inverter operation of Graetz circuit without and with overlap. Output voltage waveforms and DC voltage in both rectifier and inverter operation, Equivalent circuit of HVDC link
.

**HVDC SYSTEM CONTROL** **9**

Basic means of HVDC system control, desired features, power reversal, Basic controllers - constant ignition angle, constant current and constant extinction/ advance angle control, power control, high level controllers. Converter maloperations - misfire, arc through, commutation failure.

**HARMONICS** **9**

Harmonics in HVDC system - Characteristic and uncharacteristic harmonics - Troubles due to harmonics – Harmonic filters - Active and passive filters - Reactive power control of converters, Protection issues in HVDC, over voltage and over current protection Voltage and current oscillations, DC reactor design, DC Circuit breakers.

**RECENT TRENDS IN HVDC TRANSMISSION** **9**

CSC based HVDC system, VSC based HVDC system – Multi- terminal HVDC systems and HVDC system applications in wind power generation, Interaction between AC and DC systems

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Kimbark, E.W., “Direct Current Transmission - Vol.1”, Wiley Inter science, New York, 1971.
2. Padiyar, K.R., “HVDC transmission systems”, Wiley Eastern Ltd., 2010.
3. Kamakshaiah, S and Kamaraju, V, „HVDC Transmission‟, 1st Edition, Tata McGraw Hill Education (India), New delhi 2011.
4. Arrilaga, J., “High Voltage Direct Current Transmission‟, 2nd Edition, Institution of Engineering and Technology, London, 1998.
5. Vijay K.Sood, “HVDC and FACTS Controllers”, Kluwer Academic Publishers, New York, 2004.

**23HE03E CONDITION MONITORING OF HIGH VOLTAGE POWER APPARATUS**

| **L** | **T** | **P** | **E** | **C** |
|---|---|---|---|---|
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**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: describe the concept of condition monitoring of high voltage apparatus. (K2)
CO 2: explain different types of faults and its monitoring methods of power transformer. (K2)
CO 3: apply the diagnostic techniques for various power generation faults for rotating electrical machines. (K3)
CO 4: employ the idea of various diagnostic techniques and condition monitoring. (K2)
CO 5: Summarize the insulation materials in application area and various testing techniques. (K2)

**INTRODUCTION** **9**

Importance and necessity of maintenance-Breakdown maintenance, planned maintenance and condition based maintenance- Concept of condition monitoring of electrical equipments. Overview of Advanced tools and techniques of condition monitoring- General issues of condition monitoring – Main Components in a condition monitoring system.

**CONDITION MONITORING OF TRANSFORMER** **9**

Diagnostic test chart, Impulse fault analysis,, Partial discharge measurements and analysis Conventions diagnostic techniques- Chemical and electrical techniques , Dielectric response measurements in time domain and frequency domain – FR.

**CONDITION MONITORING OF ROTATING ELECTRICAL MACHINES** **9**

Power generation faults and monitoring methods - Motor Current Signature Analysis (MCSA) -Air-Gap Eccentricity, Broken Rotor Bars, Bearings Damage, Shorted Turns in Stator Windings-Monitoring of rotating elements - Overall level monitoring - Frequency spectrum monitoring.

**INSULATION MATERIALS AND MONITORING** **9**

Outdoor insulation: Materials, ageing, diagnostic, polymeric materials, and semi-conducting, ceramic glazes - Insulation degradation detection, Particulate detection: core monitors, chemical analysis, Gas analysis off-line, Gas analysis on-line, Lubrication oil and bearing degradation.

**FUTURE TRENDS** **9**

Reaming life analysis, Condition based maintenance and asset management, applications of Artificial Intelligence techniques in monitoring, latest methodologies and Future trends.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. W. H. Tang and Q. H. Wu, “Condition Monitoring and Assessment of Power Transformers Using computation Intelligence”, Springer, London 2010
2. Peter Tavner, Li Ran, Jim Penmanand Howard Sedding, “Condition Monitoring of Rotating Electrical Machines”, Published by The Institution of Engineering and Technology, London, United Kingdom, 2008.
3. Hamid A Toliyat, Subhasis Nandi, Seungdeog Choi, Homayoun Meshgin-Kelk, “Electric Machines: Modeling, Condition Monitoring and Fault Diagnostics”,, CRC Press.
4. Chakravorti Sivaji, Dey Debangshu, Chatterjee Biswendu, “Recent Trends in the Condition Monitoring of Transformers- Theory, Implementation and Analysis” Springer, 2013
5. Greg C. Stone, Edward A. Boulter, Ian Culbert, Hussein Dhirani, “Electrical Insulation for Rotating Machines: Design, Evaluation, Aging, Testing, and Repair”, IEEE Press Series on Power Engineering, A John Wiley & Sons, Inc., Publication, 2004
6. R.E. James and Q. Su, “Condition Assessment of High Voltage Insulation in Power System Equipment”, Published by The Institution of Engineering and Technology, London, United Kingdom, 2008

**23HE04E EHV AC POWER TRANSMISSION** **L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: explain the role of EHVAC Transmission and Mechanical considerations. (K2)
CO 2: calculate the line parameters for multi-conductor lines. (K2)
CO 3: estimate the voltage gradients of conductors. (K2)
CO 4: discuss the concepts of corona and radio interference. (K2)
CO 5: illustrate the effect of electrostatic field on humans and vehicles. (K2)

**INTRODUCTION** **9**

Line trends and preliminary aspects – Standard transmission voltages – Power handling capacities and line losses – Mechanical aspects.

**CALCULATION OF LINE PARAMETERS** **9**

Calculation of resistance, inductance, and capacitance for multiconductor lines – Calculation of sequence inductances and capacitances – Line parameters for different modes of propagation - Resistance and inductance of ground return.

**VOLTAGE GRADIENTS OF CONDUCTORS** **9**

Charge-potential relations for multi-conductor lines – Surface voltage gradient on conductors – gradient factors and their use – Distribution of voltage gradient on sub conductors of bundle – voltage gradients on conductors in the presence of ground wires on towers.

**CORONA EFFECTS** **9**

Power losses and audible losses: I2R loss and corona loss – Corona loss formula- charge voltage diagram and corona loss - Corona pulse generation and properties – Limits for radio interference fields.

**ELECTROSTATIC FIELD OF EHV LINES** **9**

Effect of EHV line on heavy vehicles – Calculation of electrostatic field of AC lines – Effect of high field on humans, animals, and plants – Electrostatic induction in un-energized circuit of a D/C line – Induced voltages in insulated ground wires.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International Pvt. Ltd., 2nd Edition, 2011.
2. Power Engineer‟s Handbook, TNEB Engineers Association, Revised and Enlarged 6th Edition, October 2002.
3. Microtran Power System Analysis Corporation, Microtran Reference Manual, Vancouver Canada. (Website: www.microtran.com)

**23HE05E ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY** **L T P E C 3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: describe the basic concepts and characteristics and design of electromagnetic compatibility (k2)
CO2: discuss the methods of grounding and cabling (k2)
CO3: summarize balancing, filtering and shielding (k2)
CO4: explain the EMI issues related to high voltage elements and circuits (k2)
CO5: appraise the EMI standard and regulations (k1)

**INTRODUCTION** **9**

Definitions of EMI/EMC -Sources of EMI- Inter systems and Intra system- Conducted and radiated interference- Characteristics - Designing for electromagnetic compatibility (EMC) - EMC regulation typical noise path- EMI predictions and modelling, Methods of eliminating interferences and noise mitigation.

**GROUNDING AND CABLING** **9**

Cabling- types of cables, mechanism of EMI emission / coupling in cables –capacitive coupling, inductive coupling- shielding to prevent magnetic radiation- shield transfer impedance, Grounding – safety grounds – signal grounds- single point and multipoint ground systems -hybrid grounds- functional ground layout –grounding of cable shields- -guard shields- isolation, neutralizing transformers, shield grounding at high frequencies, digital grounding- Earth measurement Methods.

**BALANCING, FILTERING AND SHIELDING** **9**

Power supply decoupling – Decoupling filters – Amplifier filtering – High frequency filtering shielding — near and far fields — Shielding effectiveness — Absorption and reflection loss — Shielding with magnetic material – Conductive gaskets – Windows and coatings – Grounding of shields.

**EMI IN ELEMENTS AND CIRCUITS** **9**

Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter modulation, transients in power supply lines, EMI from power electronic equipment, EMI as combination of radiation and conduction.

**ELECTROSTATIC DISCHARGE, STANDARDS AND TESTING TECHNIQUES** **9**

Static Generation- human body model- static discharges- ESD versus EMC, ESD protection in equipment- standards – FCC requirements – EMI measurements – Open area test site measurements and precautions- Radiated and conducted interference measurements, Control requirements and testing methods

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. V.P. Kodali, “Engineering Electromagnetic Compatibility”, S. Chand, 1996.
2. Henry W.Ott, “Noise reduction techniques in electronic systems”, John Wiley & Sons, 1989.
3. Bernhard Keiser, “Principles of Electro-magnetic Compatibility”, Artech House, Inc. (685 canton street, Norwood, MA 020062 USA) 1987.
4. Bridges, J.E Milleta J. and Ricketts.L.W., “EMP Radiation and Protective techniques”, John Wiley and sons, USA 1976.
5. William Duff G., & Donald White R. J, “Series on Electromagnetic Interference and Compatibility”, Vol.
6. Weston David A., “Electromagnetic Compatibility, Principles and Applications”, 1991

**23HE06E POLLUTION PERFORMANCE OF POWER APPARATUS AND SYSTEMS**

| L | T | P | E | C |
|---|---|---|---|---|
| 3 | 0 | 0 | 0 | 3 |

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: enlighten the Mechanism of pollution flashover, Analytical determination. (K2)
CO2: explain the artificial pollution testing methods. (K2)
CO 3: discuss the pollution performance of insulators. (K2)
CO 4: illustrate the pollution performance of surge diverters. (K2)
CO 5: describe the pollution performance of indoor equipments.(K2)

**INTRODUCTION** **9**

Fundamental process of pollution flashover – development and effect of contamination layer – creepage distance – pollution conductivity – mechanism of pollution flashover – analytical determination of flashover voltage.

**POLLUTION TESTING** **9**

Artificial pollution testing – Salt-fog method – Solid layer method – Monitoring of parameters – Measurement of layer conductivity – Field testing methods.

**POLLUTION PERFORMANCE OF INSULATORS** **9**

Ceramic and non-ceramic insulators – Influence of Profile on the Pollution Performance– Rib factor effect in AC and DC insulators – Various techniques to improve the performance of insulators – Properties of material used for insulators modeling under various polluted conditions.

**POLLUTION PERFORMANCE OF SURGE DIVERTERS** **9**

External insulation — Effect of pollution on the protective characteristics of gap and gapless arresters — Weather ageing test (salt fog) for surge arresters- Modeling of surge diverters under polluted conditions.

**POLLUTION PERFORMANCE OF INDOOR EQUIPMENT** **9**

Condensation and Contamination of indoor switch gear – Tracking and erosion of indoor equipment - Performance of organic insulator under polluted conditions – Accelerated testing techniques- Assessment of Environmental and System Stresses.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Kind and Karner, “High Voltage Insulation”, Translated from German by Y.Narayana Rao, Frider. Vieweg, & Sohn, Braunschweig, Weishaden, 1985.
2. Kuffel E., Zaengl W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsvier India Pvt. Ltd, 2005.
3. Klaus Ragaller, “Surges in High Voltage Networks”, Plenum Press, New York, 1980.
4. Dieter Kind and Kurt Feser, “High Voltage Test Techniques”, SBA Electrical Engineering Series, New Delhi, 2nd Edition, 1999.
5. Looms, J.S.T., “Insulators for High Voltages”, Peter Peregrinus Ltd., London, 1988.
6. Working Group D1.44, “Pollution test of naturally and artificially contaminated insulators” Cigre 2017

**23HE07E** **ADVANCED ELECTROMAGNETIC FIELDS** **L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: explain the basic concepts in electrostatics.
CO 2: illustrate the concepts of electric fields and space charge free fields.
CO 3: differentiate the techniques used for analyzing the electric fields.
CO 4: analyze the electric fields with combination of different computation techniques.
CO 5: estimate the electric fields behavior in conductors and dielectrics.

**BASICS OF ELECTROSTATICS** **9**

Electrostatic Fields – Coulombs Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge – Work done in moving a point charge in an electrostatic field – Electric Potential – Properties of potential function – Potential gradient – Gauss’s law – Application of Gauss’s Law – Maxwell’s first law – Laplace’s and Poisson’s equations – Solution of Laplace’s equation in one variable.

**ELECTRIC FIELDS ANALYSIS** **9**

Introduction – Analytical calculation of space charge free fields – Simple geometries – Transmission conductors to ground – Fields in multi dielectric media – Experimental analogs for

space charge free fields – Electrolytic tank – Semi conducting paper analog – Resistive mesh analog.

**NUMERICAL METHODS FOR FIELD CALCULATION** **9**

Numerical computation of space charge free fields – Successive imaging technique – The dipole method - charge-simulation technique – Finite-difference technique – Combined charge simulation and finite difference technique – Finite element technique – Combined charge simulation and finite element technique – Boundary element method – Integral equations technique – Montecarlo technique.

**ANALYTICAL METHODS FOR FIELD CALCULATION** **9**

Analytical calculations of fields with space charges – Numerical computation of fields with space charges finite element technique – Finite element technique combined with the method of characteristics – Charge simulation technique combined with the method of residues – Electric stress control and optimization.

**CONDUCTORS & DIELECTRICS** **9**

Behavior of conductors in an electric field – Conductors and insulators – Electric field inside a dielectric material – Polarization – Dielectric – Conductor and dielectric – Dielectric boundary conditions – Energy stored and energy density in a static electric field – Current density – Conduction and convection current densities – Ohm's law in point form – Equation of continuity.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. William H. Hayt and John. A. Buck, "Engineering Electromagnetics", Tata Mc-Graw Hill Companies, 7th Edition, 2012.
2. John Kraus and Daniel Fleisch , "Electromagnetics with Applications", McGraw-Hill Inc., 5th Edition, 2017.
3. Gangadhar, "Field Theory", Khanna Publishers, 2002.
4. Matthew N.O. Sadiku and S.V.Kulkarni, "Principles of Electromagnetics", Oxford University Press, 6th Edition, 2015.
5. Paul C.R. and Nasar S.A., "Introduction to E-Magnetics", Tata McGraw-Hill Publications, 2005.

**23HE08E ADVANCED TOPICS IN HIGH VOLTAGE ENGINEERING** **L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: Summarize the measurement and diagnostic technologies in HV measurement
CO 2: Employ $SF_6$ insulation and monitoring system
CO 3: Interpret the safety and earthing requirements for HV system.
CO 4: Explain pulsed electric field and its applications
CO 5: Summarize the role of Pulsed electric field technology in food and medical Industry.

**MEASUREMENT AND DIAGNOSTIC TECHNOLOGIES** **9**

Introduction – Digital Impulse Recorders – Digital Techniques in HV tests – Testing automation – Fundamental optical principles - Electro-optic Sensors- Magneto-optic Sensors – Measurement of very fast transients in GIS –- Space charge measurement techniques – Electro-optical image techniques

**SF6 INSULATION SYSTEMS AND THEIR MONITORING** **9**

Introduction – Ionisation phenomena -Breakdown mechanisms in low divergence fields-Nonuniform field breakdown in $SF_6$- Breakdown in GIS-Possible improvements in $SF_6$ insulation-Partial discharge diagnostic techniques for GIS- Application of UHF technique to PD detection in GIS

**REQUIREMENTS OF EARTHING AND SAFETY** **9**

Introduction – Nature of static electricity – Triboelectric series – Static electricity problems – Hazards of Electrostatic electricity in industry – Hazards from electrical equipment and installations – Equipment Earthing, Neutral Point Earthing, Substation Earthing System, Dimensioning of Earth Conductors, Step Potential and Touch Potential, Earth Mat, Resistance of Earthing System, Values of Soil Resistivity, Fencing, Procedure of Laying Earthing

**PULSED ELECTRIC FIELDS** **9**

Introduction – Definitions- Mechanisms of microbial inactivation's – Electrical breakdown – Electroporation – Inactivation models – Critical factors analysis of process, product and microbialfactors – Pulse generators and treatment chamber design – Research needs.

**PULSED POWER APPLICATIONS** **9**

Introduction - Ion beam materials treatment -Air treatment and pollution control - Pulsed corona precipitators - Biological applications - Food processing: Processing of juices, milk, egg, meat and fish-Water purification Medical applications -Ultra wideband and HPM applications - X-ray simulators.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Haddad, D. Warne, "Advances in High Voltage Engineering" published by The institution of Engineering and Technology, London, United Kingdom, 2007.
2. Malik N.H., Ai-Arainy A.A., Qureshi M.I., "Electrical Insulation in Power Systems", Marcel Dekker, Inc., 1998.
3. Mazen Abdel-Salam, Hussien Anis, Ahdab EI-Morshedy, "High Voltage Engineering", Theory and Practice, Marcel Dekker Inc., 2nd Edition, 2000.
4. Barbosa-Canovas G.V., "Pulsed electric fields in food processing: Fundamental aspects and applications" CRC Publisher Edition, March 1st, 2001.
5. Lelieveld H.L.M., Notermans S., et al, "Food preservation by pulsed electric fields: From research to application", Woodhead Publishing Ltd, October 2007.

**23HE09E ADVANCES IN ELECTRIC POWER TRANSMISSION** **L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: discuss the recent development in transmission system
CO 2: explain the design considerations in transmission system
CO 3: illustrate the function of insulators for outdoor environments.
CO 4: summarize the design considerations of substation
CO 5: Interpret the function of Gas insulated Substation (GIS)

**INTRODUCTION** **9**

Overview of primary and renewable energy sources, installed capacity and projected growth. Recent advances in UHV power transmission - introduction to 765/1200kV AC and ±500/800 kV DC transmission systems; present status and future growth

**DESIGN CONSIDERATION IN OVERHEAD TRANSMISSION LINES** **9**

Design criteria for overhead transmission lines: general system design, methodology, and reliability, wind/ice loading, security and safety requirements. Components of HV transmission systems, types of conductors/HTLS, bundle configurations, conductor accessories/clamps etc. Transmission towers: calculations of clearances for power frequency, switching and lightning surges, right of way (ROW), earth wire/OPGW.

**INSULATORS FOR OUTDOOR APPLICATIONS** **9**

Introduction – role of insulators and material properties, Examples of design, Flashover mechanisms – electrical characteristics under natural and polluted conditions, -Selection of insulators for light, medium and heavy polluted areas, performance under laboratory aging, normal and low temperatures- hybrid insulators.

**DESIGN CONSIDERATION IN SUBSTSTIONS** **9**

Up-gradation of existing transmission lines, Design considerations of UHV Substations, AIS, Hybrid-AIS - Review on insulation coordination/overvoltages for UHV systems- high performance metal oxide surge arresters, Introduction to SCADA and Substation automation- Earthing and safety measures for 765/1200kV HV substations.

**GAS INSULATED SUBSTSTIONS** **9**

Evolution of GIS, Basics of GIS technology, Key design features,SF6 volume reduction, Reliability of GIS, Design tests, Gas tightness and monitoring, Contaminants and oxidation in gas, conductors in GIS system, components in GIS, testing and installation, Global status of GIS

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Haddad, D. Warne, “Advances in High Voltage Engineering” published by The institution of Engineering and Technology, London, United Kingdom, 2007.
2. Hermann Koch, "Gas Insulated Substations", Wiley, 2014.
3. R.D.Begamudre, “Extra High Voltage AC Transmission Engineering”, 4th Edition, New Academic Science Ltd, 2011.
4. J.S.T. Looms, “Insulators for High Voltages”, IET Power and Energy Series, Volume 7, 2006.
5. CIGRE Working Group SC B.3-22 “Technical requirements for substations exceeding 800 kV”, Brochure No: 400, Dec 2009.
6. IEC-60826, International standard, “Design criteria of overhead transmission lines”, 2003.

| 23HE11E | MACHINE LEARNING | L T P E C |
|---|---|---|
| | | 3 0 0 0 3 |

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: Explain the concepts of machine learning
CO2: Explore the supervised learning techniques
CO3: Summarize the unsupervised learning techniques
CO4: Recognize the feature and optimize the features
CO5: Build Deep Learning architecture models

**INTRODUCTION** **9**

Machine Learning: History - Applications; Types of machine learning - Design of a learning system - Perspectives and issues in machine learning; Basic statistics: Variance and Covariance - Curse of dimensionality - Conditional Probability.

**SUPERVISED LEARNING** **9**

Regression: Introduction - Linear Regression - Least Squares - Under fitting and Overfitting - Cross-Validation - Lasso Regression - Logistic Regression; Classification: Linear and Non-linear models - Support Vector Machines Multi class SVM - Kernel Methods; K-Nearest Neighbours.

**UNSUPERVISED LEARNING** **9**

Unsupervised Models: Measuring dissimilarity – Spectral clustering –Hierarchical clustering – K-Means clustering – Fuzzy C Means Clustering – Dimensionality Reduction using Principal Component Analysis

**ANALYTICAL AND FEATURE LEARNING** **9**

Analytical Learning: Discovering new features – Deductive Learning – Knowledge level learning – Feature Learning : Feature Selection – Greedy Selection Approaches – Feature Manipulation and Normalization – Dictionary Learning with Auto-encoders.

**NEURAL NETWORK AND DEEP LEARNING ALGORITHM** **9**

Neural Networks: The Brain and the Neuron - Perceptron learning algorithm; Multi-Layer Perceptron: Back propagation algorithm - Error - Multi-layer perceptron in practice with Time Series Signal; Deep Learning: Introduction - Convolution Neural Networks –Training Optimizers; Role of Hyperparameters; Case Study: Image Classification.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Ethem Alpaydin, ``Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)'', Fourth Edition, MIT Press, 2020.
2. Stephen Marsland, ``Machine Learning - An Algorithmic Perspective'', Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2015
3. Kevin P. Murphy, ―Machine Learning: A Probabilistic Perspective‖, MIT Press, 2012
4. Shai Shalev-Shwartz and Shai Ben-David, ―Understanding Machine Learning: From Theory to Algorithms‖, Cambridge University Press, 2014
5. Christopher M. Bishop, ―Pattern Recognition and Machine Learning‖, Springer, 2011.
6. https://www.coursera.org/learn/machine-learning
7. http://machinelearningmastery.com/best-machine-learning-resources-forgettingstarted/
8. https://www.udemy.com/machinelearning/

**23HE12E** **PULSE POWER ENGINEERING** **L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: identify the static and dynamic breakdown strength of dielectric materials
CO 2: evaluate the energy storage in Marx generators and pulse discharge capacitors
CO 3: distinguish the types and operation of various switches
CO 4: illustrate the pulse forming networks
CO 5: recognize the pulse transmission and transformation theory

**BREAKDOWN STRENGTH OF DIELECTRIC MATERIALS** **9**

Introduction – Gases-static breakdown – Pulsed breakdown – Spark formation – Liquids – Basic electrical process – Steamer breakdown – Practical considerations – Solids – General observation – Charge transport – Injection and Breakdown – Statistical Interpretation of breakdown Strength Measurements.

**ENERGY STORAGE** **9**

Pulse Discharge Capacitors – Marx Generators – Classical Marx generators – LC Marx Generator – Basic Pulsed – Power Energy Transfer Stage – Inductive energy storage – Power and voltage multiplication – Rotors and homo polar Generators.

**SWITCHES** **9**

Closing switches – Gas switches – Semi conductor closing switches – Magnetic switches – Summary –Opening switches – Fuses – Mechanical interrupters – Superconducting opening Switches – Plasma opening switches – Plasma flow switches – Semiconductor opening switches.

**PULSE FORMING NETWORKS** **9**

Transmission lines – Terminations and junctions – Transmission lines with losses – The finite transmission line as a circuit element – Production of pulses with lossless transmission lines – RLC networks – Circuit simulation with LEITER.

**PULSE TRANSMISSION AND TRANSFORMATION** **9**

Self magnetic insulation in vacuum lines – Vacuum break down in metallic surfaces – Qualitative description of self magnetic insulation – Quantitative description of self magnetic insulation – Pulse Transformers – High Voltage Power supplies – Capacitor-Charging Techniques – Cascade Circuits –Transformation Lines.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Hansjoachim Bluhm, “Pulsed Power Systems: Principles and Applications”, Springer; 2006.
2. Pai S.T., “Introduction to High Power Pulse Technology (Advanced Series in Electrical and Computer Engineering)”, Wspc Publisher, 1995.
3. Paul W. Smith, “Transient Electronics: Pulsed Circuit Technology”, Wspc, Wiley; First Edition 2002.
4. Martin et al., J. C. Martin on Pulsed Power, Plenum Press, 1996.
5. G.A. Mesyats, Pulsed Power, Kluwer Academics/Plenum 2005.

**23HE13E** **DESIGN OF SUBSTATION** **L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: explain the fundamental concepts of AIS, GIS and MTS substation
CO2: describe the equipment and layout of AIS, GIS and MTS substation
CO3: summarize the insulation coordination of AIS, GIS and MTS substation
CO4: analyze the grounding and shielding of substation
CO5:Interpret the basic tools required for Communication, substation integration and automation.

**INTRODUCTION TO AIS, GIS AND MTS** **9**

Introduction – characteristics – comparison of Air Insulated Substation (AIS), Gas Insulated Substation (GIS), Mixed technology switchgear (MTS) substation– main features of substations,

Environmental considerations, Planning and installation- GIB / GIL - budgeting-Financing - traditional and innovative substation design.

**MAJOR EQUIPMENT AND LAYOUT OF AIS, GIS AND MTS** **9**

Major equipment – design features – equipment specification, types of electrical stresses, mechanical aspects of substation design- substation switching schemes - single feeder circuits; single or main bus and sectionalized single bus- double main bus-main and transfer bus- main, reserve and transfer bus- breaker-and half scheme-ring bus.

**INSULATION COORDINATION OF AIS, GIS AND MTS** **9**

Introduction – stress at the equipment – insulation strength and its selection – standard BILs – Application of simplified method – Comparison with IEEE and IEC standards.

**GROUNDING AND SHIELDING** **9**

Definitions – soil resistivity measurement – ground fault currents – ground conductor – design of substation grounding system – shielding of substations – Shielding by ground wires and lightning masts.

**SUBSTATION INTEGRATION AND AUTOMATION** **9**

Interface between Automation and the Substation-State (Status) Monitoring-Control Functions-Communication Networks inside the Substation-Testing Automation-Substation Communications: Supervisory Control and Data Acquisition (SCADA): Functional Requirements- Communication Requirements-Relay Communication Requirements-Components of a SCADA System-Structure of a SCADA Communication Protocol: Past, Present, and Future.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Andrew R. Hileman, “Insulation coordination for power systems”, Taylor and Francis, 1999.
2. M.S.Naidu, “Gas Insulation Substations”, I.K.International Publishing House Private Limited, 2008.
3. Klaus Ragallar, “Surges in high voltage networks” Plenum Press, New York, 1980.
4. “Power Engineer’s handbook”, TNEB Association.
5. Pritindra Chowdhuri, “Electromagnetic transients in power systems”, PHI Learning Private Limited, New Delhi, Second edition, 2008.
6. “Design guide for rural substation”, United States Department of Agriculture, RUS Bulletin, 1724E-300, June 2001.
7. AIEE Committee Report, “Substation One-line Diagrams,” AIEE Trans. on Power Apparatus and Systems, August 1953
8. Hermann Koch , “Gas Insulated Substations”, Wiley-IEEE Press,2014
9. IEEE Std 80, IEEE Guide for Safety in AC Substation Grounding – 2013
10. IS Standard 3043 “CODE OF PRACTICE FOR EARTHING (First Revision)”; 1987.
11. Working Group JWG B3.35/CIRED, “Substation earthing system design optimisation through the application of quantified risk analysis” CIGRE 749, 2018.
12. CIGRE Green Book, “Substation”, Study Committee B3, PP 83 -155.
13. Working Group WG 23.03, “General guidelines for the design of outdoor AC substations. (2nd version)” CIGRE 161, 2000.

**23HE14E FLEXIBLE AC TRANSMISSION SYSTEMS L T P E C**

**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: Explain the basic concepts of Power transmission networks and FACTS controllers (K2)

CO2: Apply and Analyze the Static Shunt Controllers and their applications in Power System (K3)

CO3: Apply and analyze the variable reactance model of Series Compensators and their Families (K3)

CO4: Explain the basic principle of operation of Unified Power Flow Controllers (K3)

CO5: Analyze the need of different FACTS controllers co-ordination and their Interaction (K3)

**INTRODUCTION** **9**

Review of basics of power transmission networks-control of power flow in AC transmission Line- Analysis of uncompensated AC Transmission line - Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Principles of operation - Steady state model and characteristics of a static voltage regulators and phase shifters - power circuit configurations

**STATIC SHUNT COMPENSATORS** **9**

Configuration of Static Var Compensator- voltage regulation by SVC- Modeling of SVC for load flow analysis Design of SVC to regulate the mid-point voltage of SMIB system- Applications: Enhancement of transient stability- Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics Applications: Steady state power transfer– Enhancement of transient stability.

**STATIC SERIES COMPENSATORS** **9**

Concepts of Controlled Series Compensation- Operation of TCSC, GCSC and TSSC - Analysis of TCSC Operation - Modeling of TCSC for load flow studies- Variable reactance model – Applications – Static Synchronous Series Compensator – Operation of SSSC and the control of power flow – Modeling of SSSC in load flow and transient stability studies – Applications: SSR Mitigation

**UNIFIED POWER FLOW CONTROLLERS** **9**

Principle of operation of UPFC and Power flow control – Modes of operation- Applications modeling of UPFC for load flow studies and transient stability studies- Principle of operation of IPFC- Applications- Comparative Evaluation and Future direction of different types of FACTS controllers.

**CO-ORDINATION OF FACTS CONTROLLERS** **9**

Controller interactions – SVC - SVC interaction– SVC-TCSC interaction- TCSC-TCSC interaction- Coordination of multiple controllers using linear Control techniques and nonlinear Control techniques – Control coordination using genetic algorithms.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Mohan Mathur R. and Rajiv K. Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc, 2002.
2. Narain G. Hingorani, “Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors, Delhi.
3. Padiyar K.R.,” FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008.

4. John A.T., "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.
5. Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.

**23HE15E POWER QUALITY L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: describe the term and definition of power quality (K2)
CO 2: Analyze voltage sag problems and suggest preventive techniques (K3)
CO 3: Identify the harmonic sources and the effects of harmonic distortion (K2)
CO 4: explain the active compensation techniques used for power factor correction (K2)
CO 5: Explain the need for harmonic filtering and the harmonic filtering devices (K3)

**POWER QUALITY – AN INTRODUCTION 9**

Overview of power quality phenomena -Basic terminologies –Power Quality Issues – Power acceptability curves- IEC and IEEE definitions-Causes for reduction in Power Quality – Power Quality Standards and Monitoring

**VOLTAGE IMBALANCE & THEIR IMPACTS 9**

Voltage variations - Voltage sags and short interruptions – flicker-longer duration variations-sources – range and impact on sensitive circuits-standards – solutions and mitigations – equipment and techniques. Interruptions - Origin of Long & Short interruptions – influence on various equipments – monitoring & mitigation of interruptions.

**SOURCES OF HARMONICS AND THEIR IMPACTS 9**

Important harmonic introducing devices – SMPS - Three Phase power converters - arcing devices saturable devices - harmonic distortion of fluorescent lamps - effect of power system harmonics on power system equipment and loads.

**HARMONIC FILTERING 9**

Active Harmonic Filtering - Shunt Injection Filter for single phase , three-phase three-wire and three-phase four wire systems-d-q domain control of three phase shunt active filters - UPS - constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag swell and flicker problems.

**COMPENSATORS-DISTRIBUTION SYSTEM 9**

Power factor improvement- Passive Compensation- Passive Filtering- Harmonic Resonance - Impedance Scan Analysis - Active Power Factor Corrected Single Phase Front End-Control Methods for Single Phase APFC -Three Phase APFC and Control Techniques - PFC Based on Bilateral Single Phase and Three Phase Converter static var compensators.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. G.T.Heydt, "Electric Power Quality", Stars in Circle Publications, 1991
2. Math H. Bollen , "Understanding Power Quality Problems", IEEE Press,1st Edition,2001
3. J. Arrillaga, "Power System Quality Assessment", John Wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A.R.Wood, Power system Harmonic Analysis, Wiley, 1997

5. Wilson E Kazibwe, Musoke H Sendaula, “Electic Power quality control techniques”, Van Nostr and Rein hold, NewYork,1993
6. J. Schlabbach,D. Blume,T. Stephanblome , “Voltage quality in Electrical Power Systems”,IEE,2001.
7. Roger C.Dugan/ Mrak F. McGranaghan, Surya santoso & H.Wayne Beaty, “Electrical power systems quality”, Tata Mc Graw-Hill, 2010.
8. George J. Walkilesh, “Power Systems Harmonics”, Springer, 2007.

**23HE16E RESTRUCTURED POWER SYSTEMS L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: analyze the basic reasons and motivations for restructuring worldwide.
CO2: explain the roles and responsibilities of different entities in electricity Market
CO3: illustrate various methods of congestion management in deregulated power system
CO4: interpret analyze the ancillary services management
CO5: differentiate the framework of US and Indian power sectors

**INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY 9**

Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behavior - Supplier behavior - Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models: Market models based on contractual arrangements - Market architecture.

**POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT 9**

Role of the independent system operator- Operational planning activities of ISO: ISO in Pool markets - ISO in Bilateral markets - Operational planning activities of a GENCO: GENCOs in Pool and Bilateral markets - market participation issues, competitive bidding

**TRANSMISSION CONGESTION MANAGEMENT 9**

Definition of Congestion - Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.

**ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK 9**

Introduction of ancillary services –Types of Ancillary services –Classification of Ancillary services – Load generation balancing related services –Voltage control and reactive power support devices –Black start capability service –Market for ancillary service –Co-optimization of energy and reserve services -International comparison - Transmission pricing –Principles –Classification – Role in transmission pricing methods –Marginal transmission pricing paradigm –Composite pricing paradigm –Merits and demerits of different paradigm- loss allocation methods.

**REFORMS INDIAN POWER SECTOR 9**

US markets: PJM market - The Nordic power market - Reforms in Indian power sector: Framework of Indian power sector - Reform initiatives - availability based tariff (ABT) - The Electricity Act 2012 - Open Access issues - Power exchange.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Mohammad Shahidehpour, Muwaffaq Alomoush, “Restructured electrical power systems: operation, trading and volatility” Marcel Dekker Pub., 2001.
2. Kankar Bhattacharya, Math H.J.Boolen, and JaapE. Daadler, "Operation of restructured power systems”, Kluwer Academic Pub., 2001.
3. Paranjothi, S.R., “Modern Power Systems: The Economics of Restructuring”, New Age International Publishers, First Edition: 2017.
4. Sally Hunt, "Making competition work in electricity”, John Willey and Sons Inc.2002.
5. Steven Stoft," Power System Economics: Designing Markets for Electricity”, Wiley-IEEE Press, 2002.
6. A.Khaparde, A.R.Abhyankar, "Restructured Power Systems", NPTEL Course, https://nptel.ac.in/courses/108101005/.

**23HE17E POWER SYSTEM PLANNING AND RELIABILITY L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO1: analyze load forecasting & reliability
CO2: describe power system economics
CO3: Summarize the knowledge related to generation and transmission planning
CO4: Interpret the generation system reliability analysis
CO5: explain the transmission system reliability analysis

**LOAD FORECASTING & RELIABILITY 9**

Classification and characteristics of loads - Approaches to load forecasting - Forecasting methodology- Energy forecasting - Basic Reliability Concepts: General reliability function, Markov Chains and processes and their applications, simple series and parallel system models - load forecasting uncertainty, Spinning Generating Capacity Reliability Evaluation: Spinning capacity evaluation.

**POWER SYSTEM ECONOMICS 9**

Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Economic Characteristics – Generation Units, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment, Optimum Investment, Tariffs.

**GENERATION AND TRANSMISSION PLANNING 9**

Objectives of generation planning - Factors affecting Generation Planning - Sources of Generation- Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage.

**GENERATION SYSTEM RELIABILITY ANALYSIS 9**

Probabilistic generation and load models- Determination of LOLP and expected value of demand not served, Determination of reliability of ISO and interconnected generation systems

**TRANSMISSION SYSTEM RELIABILITY ANALYSIS 9**

Deterministic contingency analysis-Average interruption rate method -The frequency and duration method - Stormy and normal weather effects probabilistic load flow - Fuzzy load flow probabilistic transmission system reliability analysis - Determination of reliability indices like LOLP and expected value of demand not served.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. R.L. Sullivan, “Power System Planning”, Tata McGraw Hill Publishing Company Ltd, 2012.
2. X.Wang & J.R.McDonald, “Modern Power System Planning”, McGraw Hill Book Company, 1994.
3. Dr.K.Uma Rao, “Power system operation & control”, Wiley-India, First edition, 2013.
4. Ali Chowdhury, Don Koval, “Power Distribution System Reliability: Practical Methods and Applications”, Wiley-IEEE Press, 2009.
5. Cepin, Marko, “Assessment of Power System Reliability”, Springer, 2011.

**23HE18E SMART GRID L T P E C**
**3 0 0 0 3**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

CO 1: describe the basic concepts and design of smart grid
CO 2: explain the functionalities of smart grid technologies
CO 3: Illustrate the various distributed energy technologies
CO 4: apply the various protective and communication technologies in smart grid
CO 5: employ the high performance computing for smart grid applications

**INTRODUCTION TO SMART GRID 9**

Basics of power systems-the definition of smart grid-need for smart grid-smart grid domain-enablers of smart grid- present development & International policies in Smart Grid regulatory challenges-smart-grid activities in India. Smart Grid Market Drivers- Functions of Smart Grid Components-Smart Grid Architecture

**SMART GRID TECHNOLOGIES 9**

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Distribution systems: DMS, Volt/VAR control, Fault Detection Isolation and service restoration, Outage management, High Efficiency Distribution Transformers, Phase Shifting Transformers

**DISTRIBUTED ENERGY TECHNOLOGIES 9**

Distribution Generation Technologies Introduction to Distribution Energy Sources, Renewable Energy Technologies – Micro grids – Storage Technologies –Electric Vehicles and plug – in hybrids – Environmental impact and Climate Change – Economic Issues.

**PROTECTIVE AND COMMUNICATION ELEMENTS IN SMART GRID 9**

Advanced metering Infrastructure (AMI) - AMI needs in the smart grid-Phasor Measurement Unit (PMU)-Intelligent Electronic Devices (IED) and their application for monitoring and protection-Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols.

**DATA ANALYTICS IN SMART GRID** **9**

Data Analytics: Benefits, tools, Challenges, need of artificial intelligence and machine learning for Smart grid applications, Introduction to cloud computing, edge computing, and security issues-introduction to Internet of things (IoT) - applications of IoT in Smart Grid.

**L: 45; TOTAL: 45 PERIODS**

**REFERENCES**

1. Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase, CRC, 2018.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Smart Grid: Technology and Applications, John Wiley, 2012.
3. James Momoh ,Smart Grid Fundamentals of Design and Analysis, IEEE press 2012
4. S.Borlase, “Smart Grids, Infrastructure, Technology and Solutions”, CRC Press, 1st Edition, 2013.
5. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley & sons Inc, 2012.
6. Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed & Efficient Energy”, Academic Press, 2012.
7. Vinod Chandra S. S “Artificial Intelligence and Machine Learning” PHI Learning in 2014.
8. Misra Sudip, ”Introduction to IoT” Cambridge University Press, 2014

**23AC01E** **TECHNICAL REPORT WRITING**

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**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: Enhance the knowledge of the research objectives and research process
CO2: Develop the level of readability for formulating rationale and improve writing skills
CO3: Formulate suitable sentences and key words for the research paper
CO4: Develop the skill of chapterisation and research writing
CO5: Interpretation of data through various strategies
CO 6: Implementation of basic rules and methods of citation

**INTRODUCTION TO RESEARCH** **5**

Research – Writing Definitions – Framing Objectives – Research process - Formulating Research problem – Technical terms and extended definition - Breaking up long sentences--structuring paragraphs and sentences - being concise and removing redundancy avoiding ambiguity and vagueness.

**IDENTIFICATION & COLLECTION OF SOURCES** **5**

Preparing manuscript – Skimming and Scanning – Review of literature- Identifying the problem - writing problem statements – writing hypothesis- Formulating Rationale – Research Design - linking phrases – Observation and Interview method – Framing Questionnaire – Case study

**WRITING AND DRAFTING ABSTRACT** **5**

Processing and data analysis – Identifying threats and challenges to Good Research - key skills needed to write a title - writing abstracts writing key words and introduction- Introductory phrases - Clarity in imperative sentences instruction writing – useful phrases to draft a perfect paper

**CHAPTERISATION** **5**

Main divisions and Subdivisions – Paragraph writing - coherence - Highlighting the findings - Analyzing Data collection - hedging and criticizing sections - Topic sentence --Paraphrasing and framing key points – Suitable section wise headings

**INTERPRETATION OF DATA** **5**

Non-verbal interpretation – Interpretation of Data - Abbreviations – Symbols Tables – graphs – charts - deriving result – Phrases used to Compare and Contrast -result and discussion-- skills needed to write the conclusions – avoiding common mistakes.

**BIBLIOGRAPHY** **5**

Citation methods – Writing Foot note – End note - bibliography – citation rules Basic reference format - plagiarism – acknowledgement – IEEE Research format – Research review Research paper Publication

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

1. Brent, Doug. Reading as Rhetorical Invention: Knowledge, Persuasion, and the Teaching of Research-based Writing. Urbana, National Council of Teachers of English, 1992.
2. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht, 2016
3. Robert A. Day and Barbara Gastel, How to Write and Publish a Scientific Paper‖, Cambridge University Press, 7th Edition, 2012
4. Thiel, David V. Research Methods for Engineers. United Kingdom, Cambridge University Press, 2014.

**23AC02E** **DISASTER MANAGEMENT**

| L | T | P | C |
|---|---|---|---|
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**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and manitarian response.

CO2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

**INTRODUCTION** **4**

Disaster: Definition- Factors and Significance- Difference Between Hazard and Disaster- Natural and Manmade Disasters: Difference-Nature- Types And Magnitude.

**REPERCUSSIONS OF DISASTERS AND HAZARDS** **6**

Economic Damage: Loss Of Human And Animal Life, Destruction Of Ecosystem-Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches- Man-made disaster- Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**DISASTER PRONE AREAS IN INDIA** **6**

Study of Seismic Zones: Areas Prone To Floods And Droughts-Landslides and Avalanches Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami- Post Disaster Diseases and Epidemics.

**DISASTER PREPAREDNESS AND MANAGEMENT** **6**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard-Evaluation Of Risk Application Of Remote Sensing- Data from Meteorological and other Agencies'-Media Reports Governmental and Community Preparedness.

**RISK ASSESSMENT AND DISASTER MITIGATION** **8**

Disaster Risk: Concept and Elements- Disaster Risk Reduction- Global and National Disaster Risk Situation-Techniques of Risk Assessment-Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment- Strategies for Survival. Meaning: Concept and Strategies Of Disaster Mitigation-Emerging Trends In Mitigation-Structural Mitigation and Non-Structural Mitigation-Programs of Disaster Mitigation In India.

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

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2. Tushar Bhattacharya, —Disaster Science and Managementǁ, McGraw Hill India Education Pvt. Ltd., ISBN-10: 1259007367, ISBN-13: 978-125900736, 2012.
3. Gupta Anil K, Sreeja S. Nair, "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2011.
4. Kapur Anu, "Vulnerable India: A Geographical Study of Disasters", IIAS and Sage Publishers, New Delhi, 2010.

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6. National Disaster Management Authority, Government of India, 2018, https://ndma.gov.in/images/pdf/Draft-Guidelines-thunderstorm-final.pdf

**23AC03E SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C**
**2 0 0 0**

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: Learn the Sanskrit sources of technical knowledge
CO2: Drawing their attention to a different dimension of Sanskrit literary tradition
CO3: Create awareness of the contemporary relevance of the Sanskrit sources of traditional wisdom

**INTRODUCTION 7**

Scope and meaning of study of technical literature in Sanskrit. Different disciplines-interdisciplinary approach-dimensions-contemporary relevance- important works in this direction-scientific methodology in ancient India.

**AYURVEDA 7**

Beginnings of Ayurveda in Atharvaveda-Ayurvedic literature-basic principles of Ayurveda-Pancabhutasiddhanta-Tridosasiddhanta-eight anga-s of Ayurveda- Rasacikitsa-contribution of Kerala to Ayurveda

**ASTRONOMY AND MATHEMATICS 8**

Major texts in Vedic and classical period-Vedangajyotisa-Sulbasutra-s-Aryabhatiya- Aryabhata's contribution-Varahamihira-Brahmagupta-Lalla-etc. Suryasiddhanta- Kerala school Parahita and drk systems-Later astronomical works commentaries.

**VASTUSASTRA AND ARTHASASTRA 8**

Principles of Vastusastra-Basic texts-Vastuvidya and Ecology-Iconography and sculpture-Kerala tradition of Vastusastra. Arthasastra, a historical and sociaological perspective-structure and contents of the text-emphasis to aspects of agriculture and architecture.

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

1. Ramakrishna Mission Institute ,"Cultural Heritage of India", (Vol. i and iii), Calcutta, 2010
2. Dr.P.C. Muraleemadhavan and Dr.N.K.Sundareswaran," Sanskrit in Technological Age,(Ed.)", New Bharatiya Book Corporation, Delhi, 2006
3. https://sanskritdocuments.org/articles/ScienceTechSanskritAncientIndiaMGPrasad.pdf
4. http://www.vedanta.gr/wp-content/uploads/2012/03/3_GlossaryOfCommonSanskrit Terms.pdf

**23AC04E VALUE EDUCATION L T P C**
**2 0 0 0**

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: Understand the need of values and its classification in contemporary society
CO2: Become aware of role of education in building value as dynamic social reality.

CO3: Know the importance of value education towards personal, national and global development.

**10**

Values and self-development –Social values and individual attitudes- Work ethics- Indian vision of humanism-Moral and non- moral valuation- Standards and principles-Value judgements.
Importance of cultivation of values-Sense of duty- Devotion- Self-reliance- Confidence-Concentration -Truthfulness-Cleanliness- Honesty- Humanity- Power of faith- National Unity-Patriotism-Love for nature- Discipline.

**10**

Personality and Behavior Development - Soul and Scientific attitude- Positive Thinking -Integrity and discipline-Punctuality- Love and Kindness-Avoid fault Thinking-Free from anger- Dignity of labour-Universal brotherhood and religious tolerance-True friendship-Happiness Vs suffering- love for truth-Aware of self-destructive habits-Association and Cooperation- Doing best for saving nature.

**10**

Character and Competence –Holy books vs Blind faith- Self management and Good health-Science of reincarnation- Equality- Nonviolence- Humility-Role of Women- All religions and same message-Mind your Mind-Self-control-Honesty- Studying effectively.

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

1. Sharma, S.P., "Moral and Value Education: Principles and Practices", Kanishka publishers, 2013.
2. Kiruba Charles & V.Arul Selvi.," Value Education", Neelkamal Publications, New Delhi, 2012.
3. Passi, B.K. and Singh, P.,"Value Education", National Psychological Corporation, Agra. 2004.
4. http://cbseportal.com/exam/e-books/download-free-ncert-e-book-education-for-values-in-school-a-framework/
5. http://cbseacademic.in/web_material/ValueEdu/Value%20Education%20Kits.pdf

**23AC05E CONSTITUTION OF INDIA L T P C**
**2 0 0 0**

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.

CO2: address the growth of Indian opinion regarding modern Indian intellectuals constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

CO3: address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

**HISTORY AND PHILOSOPHY OF INDIAN CONSTITUTION 6**

History-Drafting Committee, (Composition & Working). - Preamble- Salient Features.

**CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES 6**

Fundamental Rights - Right to Equality-Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy- Fundamental Duties.

**ORGANS OF GOVERNANCE** **6**

Parliament- Composition-Qualifications and Disqualifications- Powers and Functions- Executive-President-Governor-Council of Ministers- Judiciary- Appointment and Transfer of Judges-Qualifications-Powers and Functions**.**

**LOCAL ADMINISTRATION** **6**

District's Administration head: Role and Importance- Municipalities: Introduction, Mayor and role of Elected Representative-CEO of Municipal Corporation-Pachayati raj: Introduction, PRI:ZilaPachayat- Elected officials and their roles,-CEO ZilaPachayat: Position and role- Block level: Organizational Hierarchy (Different departments)-Village level: Role of Elected and Appointed officials- Importance of grass root democracy.

**ELECTION COMMISSION** **6**

Election Commission: Role and Functioning -Chief Election Commissioner and Election Commissioners-State Election Commission: Role and Functioning.-Institute and Bodies for the welfare of SC/ST/OBC and women.

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

1. Subhash .C, kashyap "Our Constitution", 5th Edition, 2017
2. www.ieagreements.org/IEA-Grad-Attr-Prof-Competencies.pdf
3. The Constitution of India, 1950 (Bare Act), Government Publication.
4. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
5. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
6. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

**23AC06E** **PEDAGOGY STUDIES** **L T P C**
**2 0 0 0**

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: Describe the pedagogical practices used by teachers in formal and informal classrooms

CO2: Understand the effectiveness of these pedagogical practices, in what conditions, and with what population of learners

CO3: Analyze how teacher education (curriculum and practicum) and the school curriculum with guidance materials support effective pedagogy

**INTRODUCTION AND METHODOLOGY** **8**

Aims and rationale, Policy background, Conceptual framework and terminology-Theories of learning, Curriculum, Teacher education.Conceptual framework, Research questions**.** Overview of methodology and Searching. Thematic overview- Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries- Curriculum- Teacher education.

**EFFECTIVENESS OF PEDAGOGICAL PRACTICES** **8**

Evidence on the effectiveness of pedagogical practices-Methodology for the in depth stage: quality assessment of included studies- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy- Theory of change-Strength and nature of the body of evidence for effective pedagogical Practices- Pedagogic theory and pedagogical approaches- Teachers attitudes and beliefs and Pedagogic strategies.

**PROFESSIONAL DEVELOPMENT** **7**

Alignment with classroom practices and follow-up support- Peer support-Support from the head teacher and the community-Curriculum and assessment-Barriers to learning: limited resources and large class sizes.

**RESEARCH GAPS AND FUTURE DIRECTIONS** **7**

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

1. Dr.S.K.Bhatia and Dr.Sonia Jindal, “A Text Book of Curriculum, Pedagogy and Evaluation”, Paragon International Publications, 2016.
2. Ackers J, Hardman F Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261, 2001.
3. Agrawal M, "Curricular reform in schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361-379, 2004.
4. Akyeampong K, "Teacher training in Ghana - does it count?", Multi-site teacher education research project (MUSTER) country report 1. London: DFID, 2003.
5. Akyeampong K, Lussier K, Pryor J, Westbrook J, "Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?", International Journal Educational Development, 33 (3): 272–282,2013.
6. Alexander RJ,"Culture and pedagogy: International comparisons in primary education", Oxford and Boston: Blackwell, 2001.
7. Chavan M, "Read India: A mass scale, rapid, ‘learning to read’", campaign, 2003.
8. www.pratham.org/images/resource%20working%20paper%202.pdf.

**23AC07E STRESS MANAGEMENT BY YOGA** **L T P C**
**2 0 0 0**

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: achieve overall health of body and mind

CO2: overcome stress

**INTRODUCTION** **10**

Introduction to Stress-Concept of Stress-Solutions through Mandukya karika - Relaxation and stimulation combined as the core for stress management-Practice of Stimulation and relaxation.

**ASAN AND PRANAYAM** **10**

Definitions of Eight parts of yoga. (Ashtanga)-Various yoga poses and their benefits for mind & body-Regularization of breathing techniques and its effects-Types of pranayam.

**YOGA AND STRESS MANAGEMENT** **10**

Concepts and Techniques of Stress Management in Ashtanga Yoga of Patanjali - specific practices for stress management-breathe awareness.

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

1. Swami Vivekananda, Advaita Ashrama ,“Rajayoga or conquering the Internal Nature”, 2016.

2. K.N.Udupa**,** **"**Stress and Its Management by Yoga", Edited by R.C.Prasad, Motilal Banarashidass Publishers, Delhi, 2010.
3. Lisa Shea,"Yoga for Stress Relief and Forgiveness", Kindle Edition, 2015.
4. BKS Iyengar, "Yoga: The path to Holstic Health", DK Publication, 2019
5. https://www.longdom.org/open-access/stress-and-yoga-2157-7595.1000109.pdf

| 23AC08E | PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS | L T P C<br>2 0 0 0 |
|---|---|---|

**COURSE OUTCOMES**

Upon completion of this course, the student will be able to

CO1: learn to achieve the highest goal happily

CO2: become a person with stable mind, pleasing personality and determination (K1)

CO3: awaken wisdom in students

**INTRODUCTION TO PERSONALITY DEVELOPMENT** **10**

The concept of personality - Dimensions of personality – Theories of Freud & Erickson- Significance of personality development. The concept of success and failure: What is success? - Hurdles in achieving success - Overcoming hurdles - Factors responsible for success – What is failure - Causes of failure-SWOT analysis.

**LIFE ENLIGHTENMENT SKILLS** **10**

Neetisatakam-Holistic development of personality, Verses 19,20,21,22 (wisdom), Verses 29,31,32 (pride & heroism), Verses 26,28,63,65 (virtue), Verses 52,53,59 (dont's), Verses 71,73,75,78 (do's).Approach to day to day work and duties, Shrimad Bhagwad Geeta, Chapter 2-Verses 41, 47,48, Chapter 3 Verses 13, 21, 27, 35, Chapter 6 Verses 5,13,17, 23, 35, Chapter 18 Verses 45, 46, 48.

**SHRIMAD BHAGWAD GEETA STATEMENTS** **10**

Statements of basic knowledge, Shrimad Bhagwad Geeta: Chapter2 Verses 56, 62, 68, Chapter 12 Verses 13, 14, 15, 16,17, 18, Personality of Role model. Shrimad Bhagwad Geeta, Chapter2 Verses 17, Chapter3 Verses 36, 37, 42, Chapter4 Verses 18, 38,39, Chapter18 Verses 37,38,63

**L: 30; TOTAL: 30 PERIODS**

**REFERENCES**

1. Swami Swarupananda Advaita Ashram, "Srimad Bhagavad Gita", Publication Department, Kolkata.
2. P.Gopinath, Rashtriya Sanskrit Sansthanam, "Bhartrihari's Three Satakam (Niti-sringar-vairagya) ", New Delhi.